

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 February 2002 (28.02.2002)

PCT

(10) International Publication Number  
**WO 02/15689 A1**

(51) International Patent Classification<sup>7</sup>: A01N 25/20,  
53/00, 65/00

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(21) International Application Number: PCT/GB01/03774

(22) International Filing Date: 21 August 2001 (21.08.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0020622.7 22 August 2000 (22.08.2000) GB

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI,  
SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU,  
ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF,  
CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD,  
TG).

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**Published:**  
— with international search report

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For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: COMBUSTIBLE PESTICIDAL PRODUCTS

(57) Abstract: A combustible pesticidal product is disclosed which comprises a structural element formed from a cardboard having a thickness of at least 0.75 mm, a density of 450-850 kgm<sup>3</sup> and consisting of 1 or more plies, the cardboard including: an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w; one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w; a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate, triammonium phosphate and mixtures thereof; a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate, boronatrocaltite and mixtures thereof; one or more pesticides; and optionally a perfume and/or a dye, which product on combustion emanates the pesticide into the atmosphere. Typically the combustible product will be a mosquito coil which has been impregnated with one or more insecticides effective against mosquitoes. On combustion of the coil, insecticide is emanated into the atmosphere for a period of at least 4 hours. However, the coils of the invention may be active against mosquitoes for 8 hours or more.

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COMBUSTIBLE PESTICIDAL PRODUCTS

This invention relates to combustible products that emanate a pesticide into the atmosphere on combustion and more particularly to such products that undergo combustion for a prolonged period thereby providing an extended time period of  
10   pesticidal activity.

Background Art

The kind of products to which this invention relates are commonly referred to as "mosquito coils". Such coils are characterised by being formed from a combustible material which is shaped into a circular helix. Included in the  
15   combustible material are one or more pesticides, which in the case of products active against mosquitoes will be insecticides. As the product burns, the insecticides are emanated into the atmosphere by virtue of their volatility. Ideally, such coils will provide an effective level of insecticide in the atmosphere for an appropriate time period.

20       Typically, mosquito coils are used in environments where persons sleep and are therefore unable to destroy mosquitoes before being bitten. Another usage is environments where infants or others incapable or having a limited ability of destroying attacking mosquitoes are placed.

It will be readily appreciated that mosquitoes are vectors for a number of  
25   particularly persistent and often life-threatening or at least debilitating diseases. Most significant among these diseases is malaria. It is therefore highly desirable to prevent mosquito bites as a means of preventing the contracting of such diseases.

Mosquitoes are particularly prevalent in tropical and sub-tropical regions. Many of these regions include countries with relatively low per capita incomes. It is  
30   therefore desirable to be able to provide pesticidal products that are highly cost effective. In general terms, traditional mosquito coils fulfil this role. They are relatively easy to form and include low cost ingredients. As emanation of the insecticide is only dependant on combustion of the coil, the only source of energy required is sufficient heat to initially ignite a coil to cause it to combust. However,  
35   one feature that is lacking in such coils is the ability to reliably provide a period of sufficient insecticidal activity while a person sleeps overnight. Typically coils should provide up to about 8 hours of insecticidal coverage. However, due to breakage, it is not uncommon for a coil to burn for a significantly shorter period of time. This requires that a person sleeping awake and recognise that the coil is not  
40   burning, then carefully relight the unbroken portion whilst ensuring that it is intact

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5 and correctly mounted. Such a requirement is not conducive to maintaining an effective overnight coverage against mosquito bites.

At this point it is worth noting that traditional mosquito coils are formed as planar circular helices in a moulding or other shaping process. At the terminal end of the coil, approximately in the centre, is a small aperture which is used to locate the mosquito coil on an upstanding pin. The upstanding pin usually projects out of a dish or tray which is used to collect the ashes of the combusted coil. Locating of the coil on the pin results in the coil separating out so as to form a continuous spiral with the beginning of the coil, which is where combustion commences, at a point lower than the terminal end which sits on the locating pin. In this way the continuous spiral forms a track which combusts from the outer beginning end to the mounted terminal end.

It should be appreciated that mosquito coils may also be formed as double circular helices. In these structures, the helices are formed co-terminously. However, prior to use, each helix must be separated out. One important reason for producing coils in this way is that of economical use of available material as well as ease of formation in manufacture.

As mentioned above, typically mosquito coils are subject to breakage. This arises out of the fact that they are quite brittle and during manufacture, rather than being produced in a planar form, coils may warp to assume a wavy or convex conformation. In some cases, a free end or tip of the coil may curl upwardly. It is therefore well recognised that breakage may occur during manufacture, packaging, transport and in use by a consumer. In this latter case, it is important that a consumer exercise considerable care in both opening and mounting a coil. More especially in the case of double helical coils, care must be taken in separating out each coil so as to avoid breakage. Again it must be emphasised that any breakage of a coil effectively results in a coil being shortened both in length and most significantly, burn time.

Whilst recognising the short comings of traditional mosquito coils, the present inventors have sought to provide an improved coil which is capable of providing a prolonged effective period of insecticidal coverage and is produced in a manner resulting in a cost effective product relative to the traditional coil.

This has been achieved by recognising that rather than using traditional fuel materials such as sawdust in the formulation of a mosquito coil, cardboard provides an effective fuel source and a prolonged burn time.

5 Disclosure of Invention

Accordingly, this invention consists in a first aspect in a combustible pesticidal product comprising a structural element formed from a cardboard having a thickness of at least 0.75 mm, a density of 450-850 kgm<sup>-3</sup> and consisting of 1 or more plies, the cardboard including:

- 10 an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;  
one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;  
a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group  
15 consisting of diammonium phosphate, monoammonium phosphate and triammonium phosphate;  
a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite;  
20 one or more pesticides; and optionally  
a perfume and/or a dye,  
which product on combustion emanates the pesticide into the atmosphere.

- In a second aspect, this invention further consists in the use of an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an  
25 alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;  
one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;  
a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate and triammonium  
30 phosphate;  
a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite;  
one or more pesticides; and optionally  
35 a perfume and/or a dye,  
in the manufacture of a cardboard-based combustible pesticidal product which on combustion emanates the pesticide into the atmosphere.

In a third aspect, the present invention still further consists in a method of forming a combustible pesticidal product comprising

5 either incorporating into a cardboard during its preparation and/or applying to a cardboard as a coating thereof:

an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an alkali earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;

10 one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;

a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate and triammonium phosphate;

15 a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite; one or more pesticides; and optionally a perfume and/or a dye.

Throughout this specification the word "comprise", or variations such as  
20 "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Whilst this invention is applicable to a variety of pesticidal substances, the preferred form relates to the use of insecticides, particularly insecticides that are  
25 effective against mosquitoes. In this form, the invention comprises a mosquito coil. In such a preferred embodiment, the product is formed from a planar sheet of cardboard which is cut into the appropriate shape. Typically the shape will be helical although not necessarily circular. It should be noted that it is within the scope of this invention to utilise multi-sided structures as described in our co-pending British  
30 patent application no. 0018998.5 "Insecticidal Coil Structure".

For the purposes of describing this invention, reference will be made to mosquito coils, although it must be appreciated that this invention is not so-limited.

It is preferred that the one or more insecticides comprise substances which are toxic to mosquitoes. Without limitation, these include esbiothrin, d-allethrin,  
35 prallethrin, transfluthrin, bioallethrin, esbioallethrin, pyrethrins, citronella, pyrethroids, neem oil and mixtures thereof. When esbiothrin, d-allethrin, prallethrin, transfluthrin, bioallethrin, esbioallethrin, pyrethrins, and mixtures thereof are used, typically they will be in an amount of from 0.01 to 0.6 % w/w, preferably to 0.02 to 0.3 % w/w, most preferably 0.04 to 0.1 % w/w. When pyrethroids, neem oil,

5 citronella and mixtures thereof are used, typically they will be in an amount of from 0.01 to 10 % w/w, preferably to 0.01 to 6 % w/w, most preferably 0.04 to 6 % w/w.

Emanation of the pesticide into the atmosphere occurs as a result of the pesticide being volatilised as the coil burns. At the front or tip of combustion of a coil, the temperature may be 200-500°C. However, behind the tip, the temperature  
10 will be somewhat lower owing to the insulation properties of the cardboard. This means that compounds such as esbiothrin which boil at 160-170°C will be volatised and released into the atmosphere behind the burning tip. Without being bound by theory, the present inventors believe that the efficacy of this invention may be due to less of a temperature gradient between the burning tip and the remainder of the coil.  
15 This results in a more effective temperature distribution across the coil thus allowing for the use of lower levels of pesticide than would usually be used.

The cardboard includes an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w. Preferably, the alkali or alkaline earth metal nitrate or nitrite will be included in an amount of from 0.04 to 1.83 % w/w, most preferably  
20 about 0.04 to 0.15 % w/w. The nitrates or nitrites that may be used include sodium, potassium, calcium, magnesium and mixtures thereof. It is preferred to utilise potassium as the nitrate or the nitrite, preferably as the nitrate.

As an alternative to the alkali earth metal nitrate or nitrite, the cardboard may include an alkali earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 %  
25 w/w. Preferably the alkali earth metal carbonate or bicarbonate will be included in an amount of from 0.02 to 3.5 % w/w, most preferably 0.82 to 1.83 % w/w. The carbonates or bicarbonates that may be used include sodium, potassium, calcium, magnesium and mixtures thereof.

It is preferred to use potassium carbonate.

30 One or more mineral silicates are included in the cardboard in an amount of from 0.01 to 8.0 % w/w. Preferably, the mineral silicates are included in an amount of from 0.01 to 4.0 % w/w, most preferably 1.5 to 3.5 % w/w. As used in this specification, mineral silicates refers to silicate compounds which may include cations such as sodium, potassium, calcium magnesium and aluminium. A preferred  
35 mineral silicate is sodium silicate. Likewise, the concentration of silicates referred to herein is determined using the ASTM Designation D3683-94 "Standard Test Method for Trace Elements in Coal and Coke Ash by Atomic Absorption, section 9.2".

A phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate,  
40 triammonium phosphate and mixtures thereof is included in the cardboard.

- 5 Preferably the phosphate is included in an amount of from 0.02 to 0.40 % w/w, most preferably about 0.14 % w/w. Furthermore, of these phosphates, diammonium phosphate is preferred.

A boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium  
10 borate, potassium borate, calcium borate, zinc perborate, boronatrocaltite and mixtures thereof is included in the cardboard. Preferably the boron compound is included in an amount of from 0.005 to 0.92 % w/w, most preferably 0.01 to 0.92 % w/w (as boron). Furthermore, of these boron compounds, sodium borate is preferred.

- It is within the scope of this invention to include a perfume and/or a dye.  
15 Both the perfume and the dye, if included, will be selected on the basis of satisfying specific organoleptic requirements. It will of course be appreciated that the perfume must be suitably stable under the conditions of combustion of the coil.

In a preferred embodiment, the structural element is made from cardboard comprising 1 to 12 plies, preferably 2 or more plies, most preferably 3 plies,  
20 especially 4 plies. Whilst the thickness of the cardboard will be from 0.75 to 3.8 mm, preferably it will be at least 2 mm, most preferably at least 2.6 mm, especially 3.0 to 3.5 mm.

- It has been found that the density of the cardboard is of importance. To achieve appropriate burn times, the cardboard has a density of  $450\text{-}850\text{ kgm}^{-3}$ ,  
25 preferably  $600\text{-}700\text{ kgm}^{-3}$ , most preferably  $650\text{-}690\text{ kgm}^{-3}$ .

The cardboard may be manufactured from a variety of pulp types including recycled pulp, Kraft pulp and thermomechanical pulp. Of these, recycled pulp is preferred as it assists in maximising combustion time of the pesticidal product.

- Within the pulp and indeed as an adherent for the plies of cardboard, starch  
30 may be used. A typical pulp may include 5 to 8 % w/w of starch. For the purposes of the present invention, an overall additional amount of about 2 to 5 % w/w may be included in the cardboard of the invention.

It will of course be appreciated that "paper" falls within the definition of "cardboard" as used in this specification.

- 35 Broadly speaking, the various materials to be included in the cardboard may be either incorporated during the preparation of the cardboard, applied as a coating after the cardboard has been formed or both incorporated and applied as a coating.

When a coating is applied, it is important to note that certain of the materials cannot be dissolved in the same solution for coating purposes. For example, the  
40 alkali earth metal nitrate or nitrite and the mineral silicates may be dissolved in the

5 same aqueous solution. Likewise, the alkali metal carbonate or bicarbonate and the mineral silicates; the alkali metal nitrate or nitrite and the phosphate and the alkali metal nitrate or nitrite may each be dissolved in the same aqueous solution.

Whilst the aforementioned materials may be applied as aqueous solutions, the one or more pesticides and the perfume are not generally water soluble.

10 Accordingly, either or both of these materials may be added to the aqueous solution of the other materials along with an emulsifier to ensure that they are uniformly dispersed. Alternatively, they may be dissolved in a solvent and separately applied either before or after the aqueous coating(s).

The inclusion of a dye is optional and depending on the selected dyes  
15 solubility may be incorporated in an aqueous solution or in a suitable solvent for separate addition as a coating. If it is incorporated in a non-aqueous solvent, then preferably the solvent will be chosen to dissolve the perfume and the one or more pesticides.

If the dye is incorporated as an aqueous solution, it may be thickened with a  
20 suitable thickening agent such as guar gum to form a paste so as to allow application by painting or rolling.

It therefore follows that to apply all of the materials as a coating, a plurality of coatings are required. In such circumstances, drying may be carried out to remove excess water between each coating.

25 Alternatively, all coatings may be sequentially applied and the resultant coated cardboard dried.

Typically the coat weight before drying will be in the range of from 5 to 240  $\text{gm}^{-2}$ , preferably 5-50  $\text{gm}^{-2}$ . In those instances where all of the materials are applied as a coating, the coat weight is most preferably 30-50  $\text{gm}^{-2}$ .

30 Application of the coatings may occur using techniques such as rolling, painting, printing or spraying. Naturally, the materials must be dissolved or dispersed in a liquid that is capable of application, desirably to obtain a uniform coating. If printing is used, well known techniques such as offset printing, gravure printing and lithographic printing may be used.

35 Conveniently, application would usually be made to one of the planar surfaces of the cardboard although both opposing outer surfaces could be coated if required.

In order to produce the requisite structural element, an appropriately dimensioned knife is used to cut out the structure from a sheet of cardboard. The resultant structural element may be in the form of a single helix or a double  
40 helix. A double helix structure is preferred as such a structure has the benefit of



5 providing two, separable combustible pesticidal products. In this embodiment, the helices will interlock over their full length.

The cardboard may be cut in a manner so as to create a product in which each of the helices remain connected by virtue of the cutting incompletely severing the cardboard. An embodiment of this type may be prepared in which a bridge, being a  
10 thin section of cardboard, is formed between adjacent portions of a helix. Such embodiments are advantageous as they provide structural support for the product. This allows for the ready packaging and shipment of the product whilst permitting a consumer to easily separate each helix from the other prior to use. In addition, it will be appreciated that a cutting knife to form such embodiments will consist of a  
15 number of separate knife segments. Thus if any knife segment is damaged, the damaged segment may be readily replaced. By contrast, when a single cutting knife is used, any damage to the knife requires complete replacement and hence greater cost.

Alternatively, cutting of the cardboard may be done in a manner such that the  
20 cardboard is completely severed. In this case, a single knife is used rather than segmented knives as described above. Whilst this has the disadvantage relative to the use of segmented knives in relation to knife damage, nevertheless it is a viable and practical option for the preparation of cardboard coils.

When produced as mosquito coils, the products of the invention may burn  
25 typically for up to 24 hours. By adjusting parameters such as the density, thickness, number of plies and mass of coil, various burn times may be obtained. For example, burn times of at least 4 hours, preferably at least 8 hours, most preferably at least 12 hours may be obtained. It will also be appreciated that the amount of the various additives such as the alkali earth metal nitrate or nitrite, the mineral silicates, the  
30 phosphate and the boron compound will affect burn time.

In order to better understand the nature of the invention, a number of examples will now be described.

#### Modes for Carrying Out the Invention

A number of examples were prepared without the inclusion of a pesticide and  
35 their burn times were evaluated as follows. It should be noted the concentrations of ingredients in the examples refer to the concentrations of materials added to the pulp or cardboard as may be the case. These concentrations do not take into account any ingredients that may have been present in the pulp or cardboard before addition of the ingredients required by the invention.

5    Example 1

Board: recycled, single ply, contains 10 % starch, density  $690 \text{ kgm}^{-3}$ , thickness 3.6 mm, weight of single coil ~15g.

Additives: added to the pulp, final concentrations in the dry board are 1.108 % w/w Potassium Nitrate and 0.554 % w/w Sodium Silicate.

10    Burn time (72 cm length coil): 7hrs 50 mins - 8 hrs 3 mins (average 7 hrs 58 mins)

Example 2

Board: recycled, single ply, contains 10 % starch, density  $685 \text{ kgm}^{-3}$ , thickness 3.6 mm, weight of single coil ~15g.

15    Additives: Sprayed onto the coils on both sides. Additive solution contains: 7.5% w/w Potassium Carbonate and 5% w/w Sodium Silicate (balance: water).

Coat weight:  $38 \text{ gm}^{-2}$ . Final concentrations in the coil after drying: 0.12% w/w Potassium Carbonate and 0.08% w/w Sodium Silicate.

20    Burn time (72 cm length coil): 6 hrs 3 mins - 6 hrs 19 mins (average 6 hrs 11 mins).

Example 3

Board: recycled, 4 ply PVA laminated, density  $587 \text{ kgm}^{-3}$ , thickness 3.0 mm, weight of single coil ~11g

25    Additives: Sprayed on both sides. First coating: 6 % w/w Sodium Borate in water at  $104 \text{ gm}^{-2}$  coat weight (giving 0.35 % w/w in the coil after drying).  
Second coating: 7.5 % w/w Potassium Carbonate and 5 % w/w Sodium Silicate in water at  $65 \text{ gm}^{-2}$  coat weight (giving 0.28 % w/w Potassium Carbonate and 0.18 % w/w Sodium Silicate in the coil after drying).

30    Note: The coil was not dried between the first and second coatings.

Burn time (72 length cm coil): 4 hrs 28 mins

A number of examples of mosquito coils were prepared incorporating active insecticides as follows:

35

Example 4

Board: recycled, 4 ply PVA laminated, density  $587 \text{ kgm}^{-3}$ , thickness 3.0 mm, weight of single coil ~11g

Additives: Sprayed onto the coils on both sides. Additive solution contains:

10 -

- 5 10 % w/w Potassium Nitrate and 5 % w/w Sodium Silicate (balance: water). Coat weight: 50 gm<sup>-2</sup>. Final concentrations in the coil after drying: 0.28 % w/w Potassium Nitrate and 0.14 % w/w Sodium Silicate. After drying, the coils were sprayed with insecticide active in solvent. The solvent used was Norpar 12 (RTM available from Exxon ) but other hydrocarbon solvents such as Norpar 13 or Exxsol D80 (RTM  
10 available from Exxon) may also be used. Concentration of the active was adjusted to obtain the desired level of active in the coil. After spraying the coils were air dried at room temperature until the solvent evaporated.

The efficacy test results are as follows (small chamber test on *Aedes*  
15 *aegypti* mosquitoes):

Lot 1 (the cardboard coils were sprayed with the active on both sides)

20	Coil:	KD50 (+/-95 % confidence intervals)
	<u>Example 5</u>	
	Cardboard, Esbiothrin 0.07 % w/w	81.5 (75.6-87.2)
	<u>Example 6</u>	
25	Cardboard, Prallethrin 0.02 % w/w	88.2 (77.2-98.8)
	Comparative coil, Esbiothrin 0.1 % w/w	81.5 (74.9-87.6)

Notes:

- 30 - KD50 is the time (in seconds) to reach knockdown of 50% of the mosquito population.

Statistical analysis indicates that the efficacies of the three coils above are not significantly different at the 5% level.

- 35 Lot 2 (the cardboard coils were sprayed with the active on one side)

Coil:	KD50 (+/- 95% confidence intervals)
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## 5 CLAIMS:

1. A combustible pesticidal product comprising a structural element formed from a cardboard having a thickness of at least 0.75 mm, a density of 450-850 kgm<sup>-3</sup> and consisting of 1 or more plies, the cardboard including:
  - 10 an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;
  - one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;
  - a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group
  - 15 consisting of diammonium phosphate, monoammonium phosphate and triammonium phosphate;
  - a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite;
  - 20 one or more pesticides; and optionally
  - a perfume and/or a dye,
  - which product on combustion emanates the pesticide into the atmosphere.
2. A combustible pesticidal product as claimed in claim 1 wherein the alkali or
- 25 alkaline earth metal nitrate or nitrite is in an amount of from 0.04 to 1.83 % w/w.
3. A combustible pesticidal product as claimed in claim 2 wherein the alkali or alkaline earth metal nitrate or nitrite is in an amount of from 0.04 to 0.15 % w/w.
- 30 4. A combustible pesticidal product as claimed in any one of claims 1 to 3 wherein the alkali or alkaline earth carbonate or bicarbonate is in an amount of from 0.02 to 3.5 % w/w.
5. A combustible pesticidal product as claimed in claim 4 wherein the alkali or
- 35 alkaline earth carbonate or bicarbonate is in an amount of from 0.02 to 1.83 % w/w.
6. A combustible pesticidal product as claimed in any one of claims 1 to 5 wherein the one or more mineral silicates is in an amount of from 0.01 to 4.0 % w/w.

- 5     7. A combustible pesticidal product as claimed in claim 6 wherein the one or more silicates is in an amount of from 1.5 to 3.5 % w/w.
8. A combustible pesticidal product as claimed in any one of claims 1 to 7 in which the one or more pesticides are insecticides, preferably esbiothrin, d-allethrin,  
10     prallethrin, transfluthrin, bioallethrin, esbioallethrin, pyrethrins, citronella, pyrethroids, neem oil and mixtures thereof.
9. A combustible pesticidal product as claimed in claim 8 wherein the one or more insecticides are selected from the group consisting of esbiothrin, d-allethrin,  
15     prallethrin, transfluthrin, bioallethrin, esbioallethrin, pyrethrins, and mixtures thereof and are in an amount of from 0.01 to 0.6 % w/w, preferably to 0.02 to 0.3 % w/w, most preferably 0.04 to 0.1 % w/w.
10. A combustible pesticidal product as claimed in claim 8 wherein the one or more  
20     insecticides are selected from the group consisting of pyrethroids, neem oil, citronella and mixtures thereof and are in an amount of from 0.01 to 10 % w/w, preferably to 0.01 to 6 % w/w, most preferably 0.04 to 6 % w/w.
11. A combustible pesticidal product as in any one of claims 1 to 10 wherein the  
25     nitrate or nitrite is selected from the group consisting of sodium nitrite, sodium nitrate, potassium nitrate, potassium nitrite, calcium nitrate, calcium nitrite, magnesium nitrate, magnesium nitrite and mixtures thereof.
12. A combustible pesticidal product as in claim 11 wherein the nitrate or nitrite is  
30     potassium nitrate or potassium nitrite, preferably potassium nitrate.
13. A combustible pesticidal product as in any one of claims to 12 wherein the carbonate or bicarbonate is selected from the group consisting of sodium carbonate, sodium bicarbonate, potassium bicarbonate, potassium carbonate, calcium  
35     bicarbonate, calcium carbonate, magnesium bicarbonate, magnesium carbonate and mixtures thereof.
14. A combustible pesticidal product as in claim 13 wherein the carbonate or bicarbonate is potassium carbonate.

- 5 15. A combustible pesticidal product as in any one of claims 1 to 14 wherein the phosphate is included in an amount of from 0.02 to 0.40 % w/w, preferably about 0.14 % w/w.
- 10 16. A combustible pesticidal product as in claim 15 wherein the phosphate is diammonium phosphate.
- 15 17. A combustible pesticidal products as claimed in any one of claims 1 to 16 wherein the boron compound is included in an amount of from 0.005 to 0.92 % w/w, preferably 0.01 to 0.92 % w/w (as boron).
18. A combustible pesticidal product as in any one of claims 1 to 17 wherein the boron compound is sodium borate.
- 20 19. A combustible pesticidal product as in any one of claims 1 to 18 wherein the product is formed from cardboard comprising from 1 to 12 plies.
20. A combustible pesticidal product as in claim 19 wherein the cardboard is comprised of 2 or more plies, preferably 3 plies, most preferably 4 plies.
- 25 21. A combustible pesticidal product as in claim 19 or claim 20 wherein the thickness of the cardboard is from 0.75 mm to 3.8 mm, preferably at least 2 mm, most preferably at least 2.6 mm.
- 30 22. A combustible pesticidal product as in claim 21 wherein the thickness of the cardboard is 3.0 mm to 3.5 mm.
23. A combustible pesticidal product as in any one of claims 1 to 22 wherein the density of the cardboard is from 600-700 kgm<sup>-3</sup>, preferably 650-690 kgm<sup>-3</sup>.
- 35 24. A combustible pesticidal product as in any one of claims 1 to 23 wherein the product is a mosquito coil having a burn time of at least 4 hours, preferably at least 8 hours, most preferably at least 12 hours.
- 40 25. A mosquito coil as hereinbefore defined with reference to any one of the examples 5-10.

5

26. Use of an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 % w/w, or an alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;

one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;

10 a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate and triammonium phosphate;

a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium

15 borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite;

one or more pesticides; and optionally

a perfume and/or a dye,

in the manufacture of a cardboard-based combustible pesticidal product which on combustion emanates the pesticide into the atmosphere.

20

27. A method of forming a combustible pesticidal product comprising either incorporating into a cardboard during its preparation and/or applying to a cardboard as a coating thereof:

an alkali or alkaline earth metal nitrate or nitrite in an amount of from 0 to 1.83 %  
25 w/w, or an alkali or alkaline earth carbonate or bicarbonate in an amount of from 0.02 to 7.0 % w/w;

one or more mineral silicates in an amount of from 0.01 to 8.0 % w/w;

a phosphate in an amount of from 0.01 to 0.40 % w/w and selected from the group consisting of diammonium phosphate, monoammonium phosphate and triammonium  
30 phosphate;

a boron compound in an amount of from 0.001 to 0.92 % w/w (as boron) and selected from the group consisting of boric acid, sodium tetraborate hydrous, sodium borate, potassium borate, calcium borate, zinc perborate and boronatrocalcite;

one or more pesticides; and optionally

35 a perfume and/or a dye.



# INTERNATIONAL SEARCH REPORT

International Application No.  
P 01/03774

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 A01N25/20 A01N53/00 A01N65/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	FR 2 705 530 A (GAMAURY JEAN FRANCOIS) 2 December 1994 (1994-12-02) page 2, line 6-14 page 3, line 1-8	1-27
A	US 5 447 713 A (ELSNER THOMAS ET AL) 5 September 1995 (1995-09-05) column 1, line 36-58 column 2, line 14-32	1-27
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

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Date of the actual completion of the international search

18 October 2001

Date of mailing of the international search report

25/10/2001

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# INTERNATIONAL SEARCH REPORT

International Application No

PC 01/03774

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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